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FABRICATION STUDIES

Course of Studies

DRAFT

1993–94 Field Review

- Introductory Level

Career & Technology
STUDIES

JULY 1993

Alberta
EDUCATION
CURRICULUM BRANCH

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FABRICATION STUDIES

A. STRAND RATIONALE

Metals are found in every part of the Earth's crust but rarely are they in usable form. To extract, refine, design, fabricate and distribute metal products and structures requires the efforts of many skilled and knowledgeable people.

Metal products and structures have shaped world history. For thousands of years, metals have been shaped, joined and poured into items that have both utilitarian and artistic value. Even today, the search goes on to develop new metals, processes and products to take us into the 21st century.

Fabrication Studies is a strand within the Construction and Fabrication area of study. Students selecting this strand will have the opportunity of combining the basic study of metals and metal processes with structural design and fabrication techniques. While many of the challenges are of a practical nature, students will have the opportunity to explore the use of metals as an art media.

Fabrication Studies will provide students with a broad base of experience related to the metals industry, which will enable them to:

- seek practical solutions to problems
- develop estimating and reporting skills
- read and communicate with drawings and symbols
- build leadership and teamwork skills
- develop self- and resource-management skills
- identify further education and career opportunities
- exercise safe work and environmental practices.

B. STRAND ORGANIZATION

CURRICULUM STRUCTURE

Fabrication Studies, like other Career and Technology Studies curricula, has been developed using a modular design. A module is a unit of curriculum that should be achieved by most students in approximately 25 hours of learning.

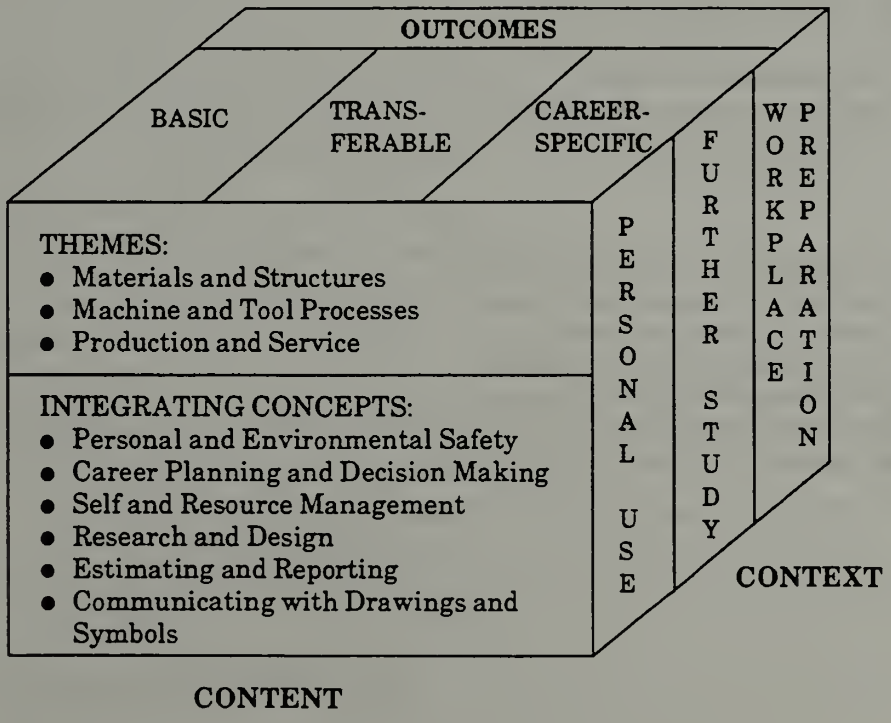
The Fabrication Studies curriculum is organized into three levels of learning: introductory, intermediate and advanced.

The Fabrication Studies strand begins with exploratory activities and becomes more specialized and demanding as the students progress towards the intermediate and advanced levels at senior high school. The introductory level contains modules that will help students build daily living skills and form the basis for further learning. Introductory modules are developed for students who have no previous experience in the strand. Intermediate level modules build on competencies developed in the introductory level and focus on developing more complex, transferable competencies. Advanced level modules require a higher degree of expertise and focus on developing specific competencies required for entry into the workplace or a related post-secondary program.

DEVELOPMENT MODEL

The Fabrication Studies development model has been developed around three themes, which are central to the transformation of metals into useful products and structures. These themes are integrated by topics, which provide a basic framework for the study of each module. The context in which the learning takes place varies according to the experience and intent of the learner. As the learner is engaged in the learning activities in the school or out in the community, specific outcomes are anticipated. These outcomes take the form of basic, transferable and career-specific knowledge, skills and attitudes constructed by the learner.

KNOWLEDGE, SKILLS AND ATTITUDES


OUTCOMES
BASIC
TRANS-FERABLE
CAREER-SPECIFIC
THEMES:
• Materials and Structures
• Machine and Tool Processes
• Production and Service
INTEGRATING CONCEPTS:
• Personal and Environmental Safety
• Career Planning and Decision Making
• Self and Resource Management
• Research and Design
• Estimating and Reporting
• Communicating with Drawings and Symbols
PERSONAL USE
FURTHER STUDY
WORKPLACE
PREPARATION
CONTEXT
CONTENT

THEMES

Each level of Fabrication Studies has major themes on which modules have been developed. The themes are:

- materials and structures
- machine and tool processes
- production and service.

PROGRAM PLANNING

The Fabrication Studies curriculum allows schools and teachers the flexibility to design programs based on the needs and interests of their students and circumstances in the school and community. The levels framework will challenge students to keep learning and will provide new and exciting opportunities at each level.

The modules have been designed to provide maximum flexibility for students and teachers to use available resources to design and fabricate products and structures. A "hands-on" activity approach will be emphasized throughout.

Teachers will select three or more modules to design a course. Criteria that should be considered in designing course sequences are:

- student interests, abilities and career aspirations
- expertise and interest of the teacher
- potential linkages with other school programs.

LINKAGES

The knowledge, skills and attitudes acquired from Fabrication Studies modules will have strong ties to core and other complementary courses. Many of the modules being developed may be beyond the resources of some schools; therefore for parts of the program it may be necessary for the student to access community resources.

The following is a three-credit course linking Fabrication Studies within CTS:

MODULES
• CFS101: Introduction to Construction Fabrication Studies • DES101: Sketching and Drawing Fundamentals • FAB116: Exploring Production Systems
RATIONALE/LEARNINGS
Students select the appropriate materials and tools to build a product or structure, develop basic visualization skills through sketching and drawing, and, for a chosen product, use decision-making skills to select and use an appropriate production system. Besides complementing the math and science curriculum, this course complements modules from Design Studies and Construction Technologies. It can also be used with Enterprise and Innovation and Management and Marketing Studies to create a venture.

FABRICATION STUDIES SCOPE AND SEQUENCE

MODULES			THEMES
INTRODUCTORY	INTERMEDIATE	ADVANCED	
Intro. to Construction and Fabrication Studies	Structural Design	Metal Testing	Materials and Structures
Basic Welding	Oxy Fuel Welding	Gas Tungsten Arc Welding	Machine and Tool Processes
	Thermal Cutting		
	Shielded Metal Arc Welding I	Shielded Metal Arc Welding II	
		Shielded Metal Arc Welding III	
	Gas Metal Arc Welding I	Gas Metal Arc Welding II	
		Gas Metal Arc Welding III	
Sketching and Drawing Fundamentals★	Print Reading and Pattern Making	Pipe Welding	
		Industrial Welding	
Principles of Sheet Metal Fabrication	Sheet Metal Fabrication I	Industrial Forming	
	Sheet Metal Fabrication II	Conical and Cylindrical Sheet Forming	
Bar and Tubular Forming	Forging Fundamentals		
Foundry I	Foundry II	Foundry III	
Principles of Machining	Precision Machining I	Precision Machining III	
	Precision Machining II	Precision Machining IV	

★ Module is available through Design Studies.

FABRICATION STUDIES SCOPE AND SEQUENCE (continued)

MODULES			THEMES
INTRODUCTORY	INTERMEDIATE	ADVANCED	
Exploring Production Systems	Custom Fabrication	Erecting Metal Structures	Production and Service
	Pre-fabrication Principles		
Computers in Design Fundamentals★	Creating a Tool Plot Path	Computer Assisted Manufacturing II	
	Computer Assisted Manufacturing I	Automated Tools	
	Residential Piping	Plumbing Systems	
	Fixtures and Appliances	Heating Systems	
	Fabrication Project	Fabrication Project	
	Fabrication Project	Fabrication Project	
		Fabrication Project	
		Fabrication Project	

★ Module is available through Design Studies.

MODULE DESCRIPTIONS

Introductory Level Modules

Module CFS101: Introduction to Construction and Fabrication Studies
This module introduces students to the safe use of tools, materials and processes to produce a useful product or structure.

Module FAB102: Basic Welding
This module introduces students to oxy-fuel and electric welding processes. Basic skills will be developed in oxy-acetylene welding and brazing, and in either gas metal arc welding or shielded metal arc welding.

Module FAB110: Principles of Sheet Metal Fabrication
This module introduces basic layout, cutting, bending and fastening operations that are commonly used to transform sheet stock into consumer products without the use of heat.

Module FAB112: Bar and Tubular Forming
This module introduces students to the use of bending equipment to create a variety of shapes with bar and tubular stock.

Module FAB113: Foundry I
In this module, the student demonstrates the skills required to make a hollow mold from sand to produce a casting.

Module FAB114: Principles of Machining
In this module, the student develops basic metal hand and power machining skills to shape and assemble a consumer product or structure.

Module FAB116: Exploring Production Systems
In this module, the student studies and compares the characteristics of typical manufacturing systems used by industry to produce a product.

C. CURRICULUM AND ASSESSMENT STANDARDS

CURRICULUM STANDARDS

Curriculum standards are expressed through learner expectations, which describe the competencies that students are expected to develop. They require students who are active learners who can combine knowledge, skills and attitudes within an applied context.

Learner expectations for Fabrication Studies are categorized in three, progressively detailed stages: strand, module and specific learner expectations.

Strand Learner Expectations

Strand learner expectations describe the overall results to be achieved by a student in Fabrication Studies. They form the basis for specific learner expectations within each module. In Fabrication Studies, *the student will:*

- develop the knowledge, skills and attitudes in the context of the school and community to achieve success in personal and work life
- apply effectively and responsible decision-making strategies in the design and fabrication of metal structures and products
- link the knowledge, skills and attitudes developed in other courses in meaningful and practical ways to the study of metal fabrication processes
- demonstrate flexibility, cooperative work behaviours, and effective communication and leadership skills
- link theory and practice using available resources, tools and materials responsibly and efficiently
- determine the economic significance of the metals industry in the local, national and global community
- expand personal knowledge and appreciation of career options and opportunities related to the metals industry.

Module Learner Expectations

Module learner expectations provide an overall curricular focus for each module. They describe what the student should know and be able to do to successfully complete the module.

Specific Learner Expectations

Specific learner expectations define the scope of learning, or content, to be covered within each module. They are a combination of knowledge, skills and attitudes and form the basis for assessment. Specific learner expectations for Fabrication Studies modules are identified on pages 11 through 28.

ASSESSMENT STANDARDS

Assessment standards describe the conditions and criteria for determining whether or not a student's performance meets the required standard. Assessment standards for each module in Fabrication Studies are under development.

MODULE CFS101: INTRODUCTION TO CONSTRUCTION AND FABRICATION STUDIES

Level: **Introductory**

This module introduces students to the safe use of tools, materials and processes to produce a useful product or structure.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • develop a working knowledge of the principal properties of common construction materials	*The student will:* • using simple tests, determine the principal properties for five or more common construction materials. Student performance is based on the: – consistent, safe use of the test equipment and materials – recording techniques – accuracy of reporting	10–20
• demonstrate basic skills related to the identification and safe use of simple hand and power tools	• identify and demonstrate the use of simple hand and power tools to process one or more materials. Student performance is based on the: – consistent, safe use of tools and materials – extent to which the tool and materials are properly identified and used	20–30
• follow a plan to make a simple product or structure from one or more natural or synthetic materials.	• with a minimum amount of assistance, select the appropriate materials, tools and processes to construct and fabricate a useful object. Student performance is based on the: – consistent, safe use of tools and materials – degree to which construction details and tolerances have been met – efficient use of time and resources – ability to work cooperatively with others.	50–60

Specific Learner Expectations

Concept	Specific Learner Expectations
Personal and Environment Safety	*The student will:* • follow safety rules and guidelines associated with the task and conditions in which he or she is working • identify common hazards associated with the use of a specific tool, material or process • inspect for and correct potential hazards within the working environment.
Common Forms and Sources of Materials	• describe the forms, shapes and sizes in which construction materials are sold, shipped and distributed • identified how these materials are safely stored and protected.
Material Properties	• examine the characteristics of a variety of construction materials in relation to their: – mechanical – electrical – chemical – optical – thermal – magnetic properties.
Structures	• define what is meant by a structure • explain the difference between a static and dynamic load and their effects on the design of a structure • determine the forces that act on a structure • demonstrate how structures can be designed to withstand loads.
Planning	• use working and assembly drawings to determine the: – size and shape of a part – method of assembly – type of finish.
Tool Processes	• identify and demonstrate the safe and efficient use of: – measuring and making tools – holding and clamping devices – driving tools – cutting tools – forming tools.

Concept	Specific Learner Expectations
Fabrication Techniques	*The student will:* ● identify and demonstrate the use of common: – mechanical joints and fasteners – adhesives – cohesives.
Finishing Techniques	● identify and demonstrate the use of oils, paints and other coatings to protect and improve the appearance of a surface.

MODULE FAB102: BASIC WELDING

Level: **Introductory**

This module introduces students to oxy-fuel and electric welding processes. Basic skills will be developed in oxy-acetylene welding and brazing, and in either gas metal arc welding or shielded metal arc welding.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • demonstrate and describe safe start-up and shut-down procedures for an oxy-fuel and an electric welding system	*The student will:* • work with minimal supervision • correctly connect and adjust the equipment for a given application • disconnect and store the equipment as instructed • meet all safety requirements	20
• demonstrate the effective use of an oxy-fuel system to braze and ferrous weld a butt and lap joint in the flat position	• demonstrate the correct start-up and shut-down procedures • demonstrate good technique and quality of work • meet all safety requirements	40
• demonstrate the effective use of a gas metal arc or shielded metal arc welding system to weld a butt and lap joint in the flat position	• demonstrate the correct start-up and shut-down procedures • demonstrate good technique and quality of work • meet all safety requirements	30
• outline the personal and trade-specific uses of welding skills.	• prepare a list of 10 or more trade or personal use applications of welding skills	10

Specific Learner Expectations

Concept	Specific Learner Expectations
	The student will:
Personal Safety	• know the hazards associated with: – flammable gases under pressure – electric cables and currents – radiation • observe and demonstrate how to protect: – eyes from chips and radiation – skin and clothing from radiation and heat – respiratory system from fumes.
• Fire Prevention	• understand the need to remove or protect all combustible materials around the welding area • identify and locate the appropriate fire extinguisher in the event of a fire.
Oxy-Fuel Equipment and Welding	• demonstrate and describe the safe use of oxy-fuel equipment, such as: – cylinders – regulators – hoses – torches – tips – igniters • demonstrate the safe start-up and shut-down of an oxy-fuel system • observe and demonstrate the use of: – an oxidizing flame – a carburizing flame – a neutral flame • practise welding butt and lap joints in the flat position.
Brazing	• understand and demonstrate the importance of having clean surfaces • determine the correct flame/heat temperature for brazing • practise brazing a butt and lap joint in the flat position.
Electric Welding	• identify the common electric welding processes • describe how an arc is produced in: – gas metal arc welding – shielded metal arc welding • indicate how the weld is protected from oxidation in: – gas metal arc welding – shielded metal arc welding.

Concept	Specific Learner Expectations
	The student will:
Gas Metal Arc Welding	• demonstrate the use of the appropriate: – type and size of electrode write – type and flow of inert gas – welding voltage and amperage – travel speed – gun geometry • practise welding butt and lap joints in the flat position *or*
Shielded Metal Arc Welding	• demonstrate the use of the appropriate: – polarity – voltage and amperage – rod type • practise welding butt and lap joints in the flat position.
Weld Quality	• evaluate welds according to their: – overall appearance – degree of penetration – amount of undercutting – degree of distortion – resistance to cracking.
Career Exploration	• investigate and list the personal and trade-specific uses of welding skills related to: – hobbies – fine art – welding as a trade – testing and inspecting – manufacturing.

MODULE FAB110: PRINCIPLES OF SHEET METAL FABRICATION

Level: **Introductory**

This module introduces basic layout, cutting, bending and fastening operations that are commonly used to transform sheet stock into consumer products without the use of heat.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • exercise proper identification and safe handling techniques of sheet stock and related products	*The student will:* • demonstrate a working knowledge of sheet metal types and gauges • handle sheet stock with due care for personal safety and material condition	10–20
• fabricate a sheet metal product or structure using two or more types of seams and methods of fastening	• work with minimal teacher supervision • follow safe work practice • select and safely use the appropriate materials and technology • minimize waste and work within the tolerance specified on the project plan • construct all joints in a secure and aesthetically pleasing manner	70–80
• identify the career options associated with sheet metal fabrication.	• prepare a list of at least three different trades and industries that use sheet metal processes.	5–10

Specific Learner Expectations

Concept	Specific Learner Expectations
Types of Sheet Stock	*The student will:* • identify common sheet metal stock by its appearance • determine the most appropriate way to safely handle and store metal stock • use a thickness gauge to determine the thickness of a piece of sheet stock.
Simple Sheet Metal Pattern Development	• develop a pattern for a simple rectangular sheet metal product using a computer or by traditional means • be aware of the effect that hems, edges, tabs and seams have on the overall size of the pattern • determine and mark the sequence and direction of the bends.
Cutting Sheet Stock	• safely use hand and machine tools to make inside and outside cuts.
Bending Sheet Stock	• demonstrate the safe use of hand or machine tools to form a product following the sequence and bend direction outlined on the pattern.
Fastening with Seams	• practise joining sheet stock together using: – flange/butt seams – lap seams – folded seams – grooved seams.
Riveting	• practise using: – tinner's rivets – pop rivets.
Threaded Fasteners	• identify the common sizes and types of screws and bolts.
Adhesives	• outline the advantages of using adhesives over other fastening techniques • identify the kinds of adhesives that work well with sheet metal stock.
Career Exploration	• investigate the use of sheet metal skills in: – heating and air condition – transportation vehicles – manufactured products.

MODULE FAB112: BAR AND TUBULAR FORMING

Level: **Introductory**

This module introduces students to the use of bending equipment to create a variety of shapes with bar and tubular stock.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • exercise proper identification and safe handling techniques of bar and tubular stock	*The student will:* • demonstrate a working knowledge of bar and tubular stock types and sizes • handle sheet stock with due care for personal safety and material condition	10–20
• fabricate a product or structure using a variety of shapes and sizes of bar and tubular stock	• work with minimal teacher supervision • select and safely use the appropriate materials and technology • minimize material waste and work to the tolerance specified on the project plan • construct all joints in a secure and aesthetically pleasing manner • apply an appropriate finish to the product	70–80
• identify the career options related to bar and tubular metal fabrication.	• prepare a list of at least three different trades and industries that use bar and tubular fabrication processes.	5–10

Specific Learner Expectations

Concept	Specific Learner Expectations
Types of Bar and Tubular Stock	*The student will:* • identify common bar and tubular stock by their size and appearance • determine the most appropriate way to safely store and handle bar and tubular stock.
Cutting Bar and Tubular Stock	• demonstrate the safe use of hand and power equipment to separate bar and tubular stock.
Bending Bar and Tubular Stock	• determine how to calculate the bend allowance for bar and tubular stock • demonstrate the safe use of hand and machine bending tools to form arcs and angles in bar and tubular materials • determine when heat is required to bend a bar or tube.
Fabrication Techniques	• demonstrate the use of mechanical fasteners and welding techniques to assemble a bar or tubular product.
Career Exploration	• investigate the use of metal fabrication skills in: – the construction industry – transportation vehicles – agriculture implements.

MODULE FAB113: FOUNDRY I

Level: Introductory

In this module, the student demonstrates the skills required to make a hollow mold from sand to produce a casting.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • identify the conditions required for the safe use of foundry equipment and materials	*The student will:* • for a specific foundry process, identify the appropriate measures to be taken to cast a product in a safe manner	20
• demonstrate the basic skills required to make a simple sand casting product	• given a simple one-piece pattern, create a mold and pour an aluminum casting using the appropriate sand, parting compounds and gating system. The product will be finished according to the specifications identified in the project plan	70
• recognize the extent that foundry processes are used in industry and the arts.	• for a list of 10 products made by casting, determine which casting process was used to make each one.	10

Specific Learner Expectations

Concept	Specific Learner Expectations
Personal and Environmental Safety	*The student will:* • demonstrate safe practices in relation to: – personal protective clothing – mold construction – set-up and lighting of the furnace – pouring – cooling.
Foundry Processes and Products	• make a list of everyday products that are made by casting • describe the major casting processes such as: – sand casting – die casting – investment – permanent method • examine foundry products to determine the production method • explain how cast parts differ from forged parts.

Concept	Specific Learner Expectations
Pattern Making	*The student will:* ● list and describe the types of patterns that are used to make sand molds ● explain why it is important for a pattern to have the proper draft and fillets ● explain why a pattern is usually larger than the intended product.
Mold Making	● demonstrate the proper use of foundry tools and materials to make a simple mold and gating system ● explain the dangers of a mold that has been packed too hard or too soft.
Heating and Pouring	● determine the melting point for the following metals – aluminum – cast iron – brass – lead alloys ● identify the dangers related to: – handling ceramic crucibles – moisture in molten metal – metal splashes – molds without proper venting – fumes from molten metal ● determine the type of flux needed to purify the metal and eliminate gases.
Finishing	● remove the gating system using the appropriate tools ● finish according to the project plan.

MODULE FAB114: PRINCIPLES OF MACHINING

Level: Introductory

In this module, the student develops basic metal hand and power machining skills to shape and assemble a consumer product or structure.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • exercise proper identification and safe handling techniques of ferrous and non-ferrous machining materials	*The student will:* • visually identify ferrous and non-ferrous materials • handle metal stock with due care for personal safety	10–20
• machine a product or structure that uses one or more machining and assembly processes	• work with minimal teacher supervision • select and safely use the appropriate materials, tools and processes to complete a task • minimize material waste and work to the tolerances specified on the project plan	70–80
• determine the personal and trade-specific uses of machining skills.	• prepare a list of 10 or more occupational or personal use applications of machining skills.	5–10

Specific Learner Expectations

Concept	Specific Learner Expectations
Personal and Environmental Safety	*The student will:* • follow safety rules and guidelines associated with the task and working conditions • identify the common hazards associated with the use of a specific tool, machining material or process • inspect for and correct potential personal and environmental hazards within the work setting.
Ferrous and Non-Ferrous Materials	• identify and describe the appearance and machining characteristics of ferrous and non-ferrous materials • match the characteristics of ferrous and non-ferrous materials to a machining application • compare the cost and availability of a variety of ferrous and non-ferrous materials.

Concept	Specific Learner Expectations
Tool Processes	*The student will:* ● make an inventory of the basic metal and power machine tools found in the school setting ● demonstrate the safe and efficient use of metal: – measuring and marking tools – holding and clamping – driving tools – cutting tools ● for a specific power machine, determine how the: – work piece is held and supported – cutting tool is held and supported – movement is applied to the tool or work piece for the cutting action – work piece or the cutting tool feed is controlled for accuracy.
Fabrication Processes	● demonstrate the use of threaded and other mechanical fastening devices.
Career Exploration	● investigate and describe the personal and trade-specific uses of machining skills related to: – hobbies – the arts – manufacturing – tools and die making – industrial machining – CNC, CAM.

MODULE FAB116: EXPLORING PRODUCTION SYSTEMS

Level: **Introductory**

In this module, the student studies and compares the characteristics of typical manufacturing systems used by industry to produce a product.

Module Learner Expectations and Assessment Standards

Module Learner Expectations	Assessment Standards	Emphasis (%)
The student will: • identify the appropriate production system to produce a product for a specific use	*The student will:* • base the choice of system on the number of products to be built, skill level and availability of resources	
• work as an effective team member to design, engineer and operate a profitable production system	• help establish a safe and profitable production system and control parameters • consistently operate in a workstation following safety guidelines and produce components with a rejection rate of less than one per cent	
• recognize the present and future career opportunities related to manufacturing.	• report on the manufacturing career opportunities in Alberta and the impact of technology on future careers.	

Specific Learner Expectations

Concept	Specific Learner Expectations
Personal and Environmental Safety	*The student will:* • follow safety rules and guidelines associated with the task and working conditions in which he or she is working • identify common hazards associated with the use of a specific tool, machining material or process • inspect for and correct potential hazards within the working environment.
Types of Manufacturing Systems	• list and describe the four basic types of manufacturing systems: – custom – job-lot – continuous – just in-time.

Concept	Specific Learner Expectations
Choosing a Manufacturing System	*The student will:* • choose a manufacturing system based on: – number of products to be produced – availability of resources – type of product – life cycle and durability of a product.
Product Design	• consider the following design standards when selecting a product: – appeal – ease of manufacture – use of standardized parts – quality – cost.
Production Engineering	• determine what tools, materials and processes will be required to manufacture the product • assist in the preparation of a flow chart that: – combines workers, machines and materials in an organized unit – requires a minimum of movement of workers and materials – identifies specific operations • make allowances for: – personal and environmental safety – easy access to utilities – ventilation – lighting – waste disposal – material and product handling.
Production Tooling	• assist in the design of jigs, template and fixtures based on: – ease of use – ability to reduce error – cost – safety.
Quality Control	• inspect the quality of the product by appearance and measurement to determine whether a product is at standard, needs reworking or should be rejected.
Career Exploration	• identify the career opportunities in the production field of manufacturing • describe the impact of technology on the future of production careers.

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